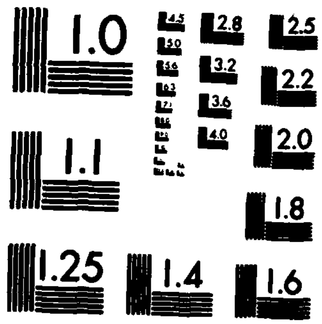
AD-A130 250 FLYING TRAINING R&Q (RESEARCH AND DEVELOPMENT) AT THE AIR FORCE HUMAN RESOURCES LABORATORY(U) AIR FORCE HUMAN RESOURCES LAB BROOKS AFB TX H J CLARK ET AL. JUN 83 1/1

UNCLASSIFIED AFHRL-TP-83-24 F/G 5/9 NL

END
DATE FILMED
8 83
DTIC



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

AFHRL-TP-83-24

(12)

AIR FORCE

HUMAN RESOURCES

ADA130250

FLYING TRAINING R&D AT THE AIR FORCE HUMAN RESOURCES LABORATORY

By

Herbert J. Clark
Kenneth W. Potempa

PLANS AND PROGRAMS OFFICE
Brooks Air Force Base, Texas 78235

DTIC
ELECTE
JUL 11 1983
S D
A

June 1983
Final Technical Paper

Approved for public release; distribution unlimited.

LABORATORY

DTIC FILE COPY

AIR FORCE SYSTEMS COMMAND
BROOKS AIR FORCE BASE, TEXAS 78235

83 07 08 088

NOTICE

When Government drawings, specifications, or other data are used for any purpose other than in connection with a definitely Government-related procurement, the United States Government incurs no responsibility or any obligation whatsoever. The fact that the Government may have formulated or in any way supplied the said drawings, specifications, or other data, is not to be regarded by implication, or otherwise in any manner construed, as licensing the holder, or any other person or corporation; or as conveying any rights or permission to manufacture, use, or sell any patented invention that may in any way be related thereto.

The Public Affairs Office has reviewed this paper, and it is releasable to the National Technical Information Service, where it will be available to the general public, including foreign nationals.

This paper has been reviewed and is approved for publication.

HERBERT J. CLARK, Director
Plans and Programs Office

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER AFHRL-TP-83-24	2. GOVT ACCESSION NO. AD-A130250	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) FLYING TRAINING R&D AT THE AIR FORCE HUMAN RESOURCES LABORATORY		5. TYPE OF REPORT & PERIOD COVERED Final 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Herbert J. Clark Kenneth W. Potempa		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS Plans and Programs Office HQ Air Force Human Resources Laboratory Brooks Air Force Base, Texas 78235		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS 62205F, 63751F, 63227F
11. CONTROLLING OFFICE NAME AND ADDRESS HQ Air Force Human Resources Laboratory (AFSC) Brooks Air Force Base, Texas 78235		12. REPORT DATE June 1983 13. NUMBER OF PAGES 10
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)		15. SECURITY CLASS (of this report) Unclassified 15.a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of this abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

flying training
pilot selection
simulators

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This paper describes the Air Force Human Resources Laboratory and its research and development (R&D) programs in Flying Training. Studies in flight simulation, part-task trainer development, performance measurement, and pilot selection are described. R&D issues in Flying Training which merit continued attention are discussed, and opportunities for participation in Air Force sponsored R&D programs by universities and industrial organizations are briefly outlined.

DD Form 1473 1 Jan 73 EDITION OF 1 NOV 65 IS OBSOLETE

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

AFHRL Technical Paper 83-24

June 1983

FLYING TRAINING R&D AT THE AIR FORCE HUMAN RESOURCES LABORATORY

By

Herbert J. Clark

Kenneth W. Potempa

PLANS AND PROGRAMS OFFICE
Brooks Air Force Base, Texas 78235

Accession For	
NTIS GRA&I	☒
DTIC TAB	☐
Unannounced	☐
Justification	
By	
Distribution/	
Availability Codes	
Dist	Avail and/or Special
A	

DTIC COPY INSPECTED 2

Reviewed and submitted for publication by

Herbert J. Clark
Director, Plans and Programs Office

Paper presented at the Aviation Psychology Symposium, Ohio State University, Columbus, 27–29 April 1983.

FLYING TRAINING R&D AT THE AIR FORCE HUMAN RESOURCES LABORATORY

INTRODUCTION

Flying Training research and development (R&D) in the United States Air Force is carried out principally by the Air Force Human Resources Laboratory (AFHRL) which has four major locations in the United States. The Laboratory Headquarters, the Manpower and Personnel Division, and the Technical Services Division are located at Brooks AFB, San Antonio, Texas. The Operations Training Division and the Logistics and Human Factors Division are located at Williams AFB, Phoenix, Arizona, and Wright-Patterson AFB, Dayton, Ohio, respectively. The Training Systems Division is located at Lowry AFB, Denver, Colorado. Each of these Divisions is colocated with, or located very near, the users of its R&D products.

The mission of AFHRL is to conduct R&D in the areas of Selection and Classification, Logistics and Technical Training, and Flying Training. Selection and Classification R&D addresses recruitment, selection and assignment, productivity, and retention. Logistics R&D focuses on the productivity of maintenance personnel and on the specification of logistics requirements during the weapons systems acquisition process. Technical Training R&D concentrates on the design of maintenance simulators and on the development of computer and instructional technologies to improve Air Force resident school and on-the-job training. Flying Training R&D centers on developing new simulation and training device technologies for application to aircrew training programs.

FLYING TRAINING PROGRAM

Simulator Effectiveness

Much of the Laboratory R&D in Flying Training is performed at Williams AFB and uses the AFHRL Advanced Simulator for Pilot Training (ASPT). This simulator, which became operational in 1975, consists of two cockpits mounted on six-degrees-of-freedom motion platforms with wide-angle infinity optics visual displays and a black-and-white computer-generated image of the flight environment. The cockpits are currently configured as A-10 and F-16 aircraft and can simulate all aspects of flight training, including a limited simulation of air-to-air and air-to-surface combat scenarios. An instructor operator station permits problem insertion, subject monitoring, and performance measurement.

Some of the Flying Training R&D performed by AFHRL has advanced the state-of-the-art in flight simulator hardware. Projection devices and computer image generation (CIG) techniques have been developed to improve simulator scene content for training pilots in realistic air-to-air and air-to-surface environments. Ongoing R&D will add color, more scene detail, better resolution, and additional offensive and defensive air-to-air and air-to-surface threats to the ASPT visual scene. Other enhancements will include simulated air-to-air combat options of 1 versus 1, 2 versus 1, and 2 versus 2. Each of these enhanced CIG features is being integrated into the ASPT F-16 configuration.

Initially, the behavioral R&D conducted on the ASPT supported the Air Force Undergraduate Pilot Training (UPT) program. Contributions were made to the development of the UPT flying training syllabus and the Instrument Flight Simulator training syllabus. Several studies have also been conducted on the transfer of training effectiveness of platform motion. Based on a review of six such studies, Martin (1981) concluded that platform motion cueing results in negligible transfer of training for initial jet piloting skills. She also concluded that existing (1980) platform systems would not significantly increase the transfer of training of tasks that call for more advanced piloting skills, such as air-to-air combat and nap-of-the-earth flight. All studies reported by Martin employed a wide field-of-view, black-and-white visual display with a six-degrees-of-freedom motion platform.

More recent behavioral R&D has focused on advanced air combat tactics training, rather than on UPT. For example, ASPT A-10 and F-16 simulations have demonstrated positive transfer of training from the A-10 ASPT to the gunnery range (Gray, Chun, Warner, & Eubanks, 1981). Seventeen pilots were trained in air-to-ground weapons delivery in the simulator and then were tested on the actual gunnery range. In conventional dive bombing tasks, simulator-trained pilots had a circular error of 75 feet, whereas pilots with no pretraining (N=7) had an average error of 94 feet. Instructor pilots had an average error of only 56 feet, but in some cases were outscored by their simulator-trained students. In the strafing task, 61% of the rounds fired by the simulator-trained group hit the target, as compared to only 41% of the rounds fired by the non-simulator-trained group.

The results on the gunnery range suggested the value of extending simulation training to full combat training. A first effort which demonstrated that simulators could be used for this extended role was reported by Kellogg, Prather, and Castore, (1980). The ASPT visual scene was modified to depict a hostile environment complete with mountains, hills, flatlands, and enemy weaponry, including anti-aircraft artillery and surface-to-air missiles (SAMs) at strategic locations. The pilot could see muzzle flashes from the anti-aircraft batteries, which had a kill probability of 100% if the pilot allowed one to achieve a tracking solution for 6 seconds. A pilot who flew within the firing envelope of a SAM would hear a warning tone from the electronic warfare equipment and see the missile in flight. The SAM could be evaded with proper maneuvering. The pilot's task was to fly into the hostile area, locate and destroy a tank, and fly out safely. Seven combat qualified pilots served as subjects, and their performance was evaluated in terms of whether they found and destroyed the tank and flew out of the hostile area safely. By the conclusion of the first 10 trials, the target was being destoyed more than 80% of the time, but only 60% of the pilots survived. After 20 trials, the number of targets destroyed remained the same, but the survival rate increased from 60% to 80%. With experience, pilots were able to attend more to the defensive task. The study clearly indicated that combat tasks can be trained in a simulator.

Another study (Hughes, Brooks, Graham, Sheen, & Dickens, 1982) took the next logical step of assessing whether combat-like simulator training resulted in improved performance in the aircraft. Eleven A-10 pilots participating in an Air Force RED FLAG war game were given training in the ASPT prior to flying the RED FLAG exercise. Training consisted of both interdiction and close-air-support missions in a simulated electronics warfare environment where the threat approximated that of a typical enemy air defense system. The 11 pilots with simulator training survived 89% of the total sorties flown, whereas those without pretraining survived only 75% of the sorties. These results provided the first evidence of transfer of training from the simulator to the aircraft under combat conditions.

Part-Task Trainers

In addition to conducting transfer-of-training studies on full mission simulators, AFHRL scientists have also been investigating the effectiveness of part-task trainers. In one transfer of training study, Nullmeyer and Laughery (1980) evaluated a B-52 air refueling part-task trainer (ARPTT) that consisted of a cockpit, visual system, platform motion system, and instructor operator station. The subjects were 98 Air Force pilots undergoing training for certification or recertification as B-52 aircraft commanders. All were either current B-52 co-pilots, former B-52 aircraft commanders, or pilots cross-training from a different aircraft. Without training on the ARPTT, the co-pilots required an average of 9.9 in-flight sorties to reach proficiency. When trained to proficiency on the ARPTT, however, they required only 5.8 aircraft sorties to reach in-flight proficiency. Pilots transitioning from other aircraft showed a reduction from 10.6 sorties to 9.2 sorties, and former B-52 commanders had a reduction from 4.6 sorties to 3.4 sorties. In all cases, proficiency was assessed by instructor pilots using standardized rating forms.

In another study, Pohlman and Edwards (1983) investigated the effectiveness of a microcomputer-based desk-top trainer used to teach F-16 cockpit stores management. Cockpit stores management involves selecting, arming, and firing a broad spectrum of aircraft weaponry by pressing buttons and interpreting displays. An experimental group learned to perform air-to-surface weapons delivery tasks using a part-task trainer that consisted of a computer-assisted interactive graphics display, while a control group received the same training using an illustrated programmed text. After training, both groups were tested on their ability to perform similar tasks on the actual F-16 stores control panel. The experimental group was able to complete the task in significantly less time and with fewer errors than the control group, thus supporting the conclusion that inexpensive microcomputers coupled with computer graphics systems can effectively provide self-instructional, interactive training to aircrews for selected procedural tasks.

By combining the best features of the large, full mission simulators and the smaller portable part-task trainers, AFHRL is now developing a helmet-mounted display that can be used to simulate complex wartime missions. Called the Combat Mission Trainer, it is intended to augment or replace the large, expensive wraparound mosaic or dome type displays now in use. The affordability and transportability of a Combat Mission Trainer will make it possible to train combat missions at the squadron level and to deploy the simulator with the squadron, if necessary.

Performance Measurement

The development of automated aircrew performance measures has been a continuing effort at AFHRL since the 1960's. Early work centered on the measurement of performance in the T-37 aircraft. Measures were developed for takeoff, landing, formation flight, instrument flight, air refueling, and basic aerobatics. The automated system for measuring pilot performance in the ASPT is described in Fuller, Waag, and Martin (1980).

Two programs now under development are the C-5A aircrew performance measurement system and the air-to-air combat measurement system. The C-5A system will objectively measure and score all aspects of individual and flight crew performance in the areas of checklists and procedures, aircraft state parameters, and navigational profiles. Approximately 3,000 separate measures can be taken, and weights assigned to these measures based on criticality of the performance for the particular maneuver being flown. Algorithms now being developed will combine the individual measures and derive overall mission assessments. When completed, the measurement system will be installed in the C-5A simulator and also in the C-5A aircraft, thereby allowing comparisons to be made of aircrew performance in both the simulator and aircraft.

In measuring air-to-air combat performance, the approach has been to relate aircraft handling variables to number of engagement kills. In a study by Kelly, Wooldridge, Hennessy, Vreuls, Barnebey, Cotton, and Reed (1979), 28 such measures were related to air combat maneuvering experience. Thirty subjects were divided into three groups based on experience level: students with only basic fighter maneuver training, students in advanced training, and air combat instructor pilots. During 405 air combat engagements in the simulator, the basic and advanced students had about 20% kills, whereas the instructor pilots had over 40% kills. Each subject was measured on 28 variables to determine how the performance of the high and low skill groups differed. Multivariate discriminant analyses were performed, and results were incorporated into an algorithm containing 13 measures including altitude change rate, speed brake and throttle usage, offensive time, and energy management. These measures accounted for 51% of the variance in the performance data and discriminated between members of the high and low skill level groups with 92% accuracy. While this and other approaches examined have been useful for assessing overall maneuvering performance, they have not provided good diagnostic information. Measures are still needed to define what went wrong, where it went wrong, and why. This information can then be incorporated into flight screening and training programs.

Selection Classification

Current R&D on aircrew selection and classification focuses on developing new UPT selection devices. Presently, the UPT screening decision is based on Air Force Officer Qualifying Test scores, medical examinations, and light aircraft (T-41) flying evaluations. Additional measures now being developed at AFHRL for better prediction of success in training and in the operational flying environment include psychomotor tests and measures of a candidate's ability to process information and make decisions while performing complex flying tasks. These new measures and others, based on training grades and class rank, will be evaluated against flying performance in both the training and operational environments. Initial analyses of data are encouraging and suggest that the new measures can be used to predict better whether a student will pass or fail UPT. The measures will also be assessed for their effectiveness in screening pilots for assignment to a fighter-attack-reconnaissance pilot training track or a tanker-transport-bomber track, following a common primary phase of training. This R&D is in response to the planned inauguration of a Specialized Undergraduate Pilot Training program, commonly referred to as a "dual-track" flying training program, that will begin in 1986.

CONTINUING R&D ISSUES

The foregoing is by no means a complete summary of all the R&D conducted at AFHRL in the Flying Training area over the past several years. It is only a sample of studies recently completed or now underway. Although inclusion of additional studies would add to the overall R&D picture, the conclusion would remain the same: more data are required to adequately answer the numerous selection, classification, and training questions being asked daily by Air Force managers, engineers, and training specialists.

Despite years of R&D by behavioral scientists in government, industry, and universities, perennial questions remain. What type person makes the best fighter pilot? Transport pilot? Bomber pilot? How quickly do flying skills decay? Can these skills be retrained best in a simulator or in an aircraft? At what cost differential? What degree of simulator fidelity is required? The answers to these questions are not simple. Yet, behavioral scientists must answer them or training courses and training devices will continue to be developed only in terms of engineering design criteria and expert opinion rather than in terms of training effectiveness criteria based on experimental data. Moreover, program managers will continue to assign low priorities to behavioral science R&D programs.

What may be required to provide more comprehensive answers to these questions is a concerted effort by multidisciplinary teams working together on well defined practical problems. These team efforts should have a higher payoff than dispersed individual efforts that often address only very small percentages of the variance associated with the total behavior in question. The knowledge of multidisciplinary teams often permits a broader perspective of the problem. A practical orientation is also required. For Air Force exploratory and advanced development projects, the potential for a practical payoff must be demonstrated before the project is approved and funded. The problem must also be well defined and thoroughly related to already published data so that the potential for generalization is increased. Generalizability is the goal; specificity is the rule. Too many behavioral studies have not only had little value for practical application, but have also had little relationship to any theoretical knowledge base. The results stand alone.

As the Air Force lead organization for conducting Flying Training R&D, AFHRL frequently calls upon the talents of universities and industrial organizations for assistance. The usual method is through the solicited proposal process, although unsolicited proposals are also welcome. Two other means of participating in Air Force R&D programs are through a 10-week Summer Faculty Research Program (SFRP) for faculty and graduate students and through the Intergovernmental Personnel Act (IPA) of 1970 which permits 1-year appointments of scientists to Air Force laboratories. The SFRP is sponsored by the Air Force Office of Scientific Research (AFOSR) and conducted by the Southeastern Center for Electrical Engineering Education (SCEE). Detailed information on application procedures can be obtained from SFRP Program

Director, SCEE Management Office, 1101 Massachusetts Avenue, St Cloud, Florida 32769. The 1984 program runs between 15 May and 30 September 1984 with a flexible start date for the 10-week session. The graduate student research period must coincide with the appointment period of the supervising professor with whom the student is working. The IPA appointments are sponsored by AFOSR at Bolling AFB, Washington DC 20332, and by individual laboratories. Persons seeking IPA appointments with AFHRL should submit inquiries to AFHRL/XR, Brooks AFB, Texas 78235. Applications for both the IPA program and the SFRP are welcome.

REFERENCES

Fuller, J.H., Waag, W.L., & Martin, E.L. Advanced simulator for pilot training: Design of automated performance measurement system. AFHRL-TR-79-57, AD-A088 855. Williams AFB, AZ: Operations Training Division, Air Force Human Resources Laboratory, August 1980.

Gray, T.H., Chun, E.K., Warner, H.D., & Eubanks, J.L. Advanced flight simulator: Utilization in A-10 conversion and air-to-surface attack training. AFHRL-TR-80-20, AD-A094 608. Williams AFB, AZ: Operations Training Division, Air Force Human Resources Laboratory, January 1981.

Hughes, R., Brooks, R., Graham, D., Sheen, R., & Dickens, T. Tactical Ground Attack: On the Transfer of Training from Flight Simulator to Operational RED FLAG Range Exercise. Proceedings of the 26th Annual Meeting of the Human Factors Society, 1982, 596-600.

Kellogg, R., Prather, E., & Castore, C. Simulated A-10 combat environment. Proceedings of the 24th Annual Meeting of the Human Factors Society, 1980, 573-577.

Kelly, M.J., Wooldridge, L., Hennessy, R.T., Vreuls, D., Barnebey, S.F., Cotton, J.C., & Reed, J.C. Air combat maneuvering performance measurement. AFHRL-TR-79-3, AD-A077 429. Williams AFB, AZ: Flying Training Division, Air Force Human Resources Laboratory, September 1979.

Martin, E.L. Training effectiveness of platform motion: Review of motion research involving the advanced simulator for pilot training and the simulator for air-to-air combat. AFHRL-TR-79-51, AD-A095 930. Williams AFB, AZ: Operations Training Division, Air Force Human Resources Laboratory, February 1981.

Nullmeyer, R., & Laughery, K. The effects of ARPTT training on air refueling skill acquisition. UDRI-TM-80-39. Dayton, OH: University of Dayton Research Institute, 1980.

Pohlman, D., & Edwards, B. Desk top trainer transfer of training to performance. Air Force Conference on Technology in Training and Education, Air Force Academy, April 26, 1983.